



**INDIANAPOLIS POWER & LIGHT COMPANY**

**REPORT IN RESPONSE TO**

**O'NEILL CONSULTING INDEPENDENT ASSESSMENT OF**

**INDIANAPOLIS POWER & LIGHT COMPANY'S**

**DOWNTOWN UNDERGROUND NETWORK**

**FOR THE YEAR ENDED 2012**

**JANUARY 25, 2013**



## Table of Contents

1. Introduction .....	3
2. Summary of work completed by IPL .....	4
3. Tier I recommendation completion results .....	5
3.1. Recommendation #1: Citizens Energy Coordination .....	7
3.2. Recommendation #2: Enhanced Inspections .....	10
3.3. Recommendation #3: Material Standards.....	18
3.4. Recommendation #4: Network Protector & Transformers .....	19
3.5. Recommendation #5: Asset Management .....	21
4. Tier II recommendation completion results .....	25
4.1. Recommendation #6: Inspection Technology .....	27
4.2. Recommendation #7: SCADA Project .....	30
4.3. Recommendation #8: Small Scale Technology .....	33
4.4. Recommendation #9: GIS Mapping & Modeling .....	36
4.5. Recommendation #10: Oil Testing & FR Fluid.....	38
5. Summary and conclusion.....	39
6. List of ongoing reports and follow - up.....	40
Appendix A - IPL Schedule Gantt Chart.....	41

## List of Figures

Figure 3-1 Portion of minutes of coordination meeting .....	8
Figure 3-2 Primary cable and splice failure trend .....	9
Figure 3-3 Asset Management web view of tablet inspection results .....	12
Figure 3-4 Detailed results from previous screen showing picture link and on-site repairs.....	13
Figure 3-5 Handheld tablet picture with technician note on picture .....	14
Figure 3-6 Acknowledged alarm and work order reference in Ivara.....	15
Figure 3-7 Work order as it appears in work management with indicator .....	16
Figure 3-8 Debris captured by Deflector Shield .....	20
Figure 3-9 First page of failure form.....	23
Figure 3-10 Last page of failure form with signatures.....	24
Figure 4-1 Technician inspecting with tablet .....	27
Figure 4-2 Sample section of tablet question flow chart.....	28
Figure 4-3 Docked tablet computer .....	28
Figure 4-4 Sample email alert from MobileFrame .....	29
Figure 4-5 Two screen shots of network displays on SCADA .....	31
Figure 4-6 Sample screen from PI for network.....	32
Figure 4-7 Cable fault indicator .....	34
Figure 4-8 SWIVELOC™ manhole cover installation .....	35
Figure 4-9 High level view of CYME model.....	37

## List of Tables

Table 3-1 Tier I O'Neill recommendations completion status .....	5
Table 3-2 Tier I IPL commitment completion status .....	6
Table 3-3 Manhole criticality ratings .....	11
Table 3-4 Ivara Repair order summary .....	11
Table 3-5 Ivara repair order examples .....	17
Table 4-1 Tier II O'Neill Consulting recommendation completion status .....	25
Table 4-2 Tier II IPL commitment completion status .....	26
Table 6-1 IPL ongoing report and follow-up commitments .....	40

# 1. Introduction

In September, 2011, in response to a recent increase in network incidents, O'Neill Management Consulting, LLC, (O'Neill Consulting) was engaged by the Indiana Utility Regulatory Commission (IURC) to audit the electrical network in downtown Indianapolis, which is owned and operated by Indianapolis Power & Light Company (IPL).

O'Neill Consulting performed a detailed analysis of IPL facilities and asset management practices related to the network. O'Neill Consulting issued their *Independent Assessment of Indianapolis Power & Light's Downtown Underground Network* in December 2011<sup>1</sup>. The report offered ten recommendations in two tiers to help improve the performance and operation of the IPL network system. Tier I contained five recommendations considered to be the highest emphasis. Tier 2 contained five recommendations that had less emphasis.

IPL issued the response to the O'Neill Consulting report in January 2012<sup>2</sup>. The IPL response included specific commitments and a timeline to address each of the ten recommendations. In some cases, the commitments exceeded the O'Neill Consulting recommendations. IPL proposed to complete a majority of the action items by the end of 2012. Some commitments included an update at the end of 2013. Other commitments included updates for year-end 2013 and 2014.

IPL staff worked closely with representatives from O'Neill Consulting from inception of the study to completion of the commitments. The close working relationship included several site visits along with numerous conference calls.

- A monthly conference call included leadership from IPL and O'Neill Consulting to discuss the current status of each recommendation and the plans going forward.
- Conference calls between O'Neill Consulting and IPL representatives occurred every week unless mutually agreed to cancel or reschedule.
- Face to face meetings took place on April 30, 2012 and May 1, 2012 to discuss and develop criteria used to determine when a recommendation would be considered complete.
- O'Neill Consulting conducted on-site asset field inspections on November 13-14, 2012 to evaluate IPL's improved inspection process and IPL's follow-up for repairs. O'Neill Consulting checked a sample of manhole and vaults that IPL inspected and repaired using the improved system.

This is IPL's 2012 report in response to the ten O'Neill Consulting recommendations and all specific commitments made in January 2012. It provides detailed results along with tabular summaries grouped by the Tier I and Tier II recommendations. IPL will provide additional reports for specific items in 2013 and 2014 as per the specific commitments. The commitments that require additional future reporting are listed in Section 6.

O'Neill Consulting has now completed the scope of the consulting engagement. IPL completed the O'Neill Consulting recommendations and has satisfied nearly all of IPL's commitments. IPL will continue working to satisfy all commitments to the IURC that are due in 2013 and 2014. Overall, IPL raised the standard of care for network assets, accelerated asset replacement, and improved its internal asset management processes.

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<sup>1</sup> Link to O'Neill Report:

[http://www.in.gov/iurc/files/IPL\\_Downtown\\_Network\\_Audit\\_Report\\_-\\_Final\\_Report\(1\).pdf](http://www.in.gov/iurc/files/IPL_Downtown_Network_Audit_Report_-_Final_Report(1).pdf)

<sup>2</sup> Link to IPL Action Plan [http://www.in.gov/iurc/files/IPL\\_Action\\_Plan\(1\).pdf](http://www.in.gov/iurc/files/IPL_Action_Plan(1).pdf)

## 2. Summary of work completed by IPL

IPL has a long list of accomplishments to satisfy the recommendations and commitments for the downtown electrical network in Indianapolis. The accomplishments include:

- 48% improvement for network reliability in 2012 compared to 2011 (Fewer problems with primary cable, secondary cable, transformers, etc.)
- 500+ Inspection-generated repair work orders (W.O.) from 2011 inspections completed
- 202 Swiveloc™ locking manhole covers were installed (152 before the Super Bowl, 50 later in 2012)
- 315 Termination chambers changed to fire retardant fluid
- 315 Network transformers tested for Dissolved Gas Analysis (sets a baseline for future tests)
- 154 Deflector shields installed over transformer/protector (avoids corrosion)
- Fault detectors installed on 43 of 44 circuits for faster feeder restoration (44<sup>th</sup> install will occur after proactive cable replacement)
- 65 Network protectors checked for aluminum bus. Only 25 had aluminum bus. 7 have been replaced
- 6 Network transformers acquired with new specifications (no termination chamber), 1 installed
- 18 Network transformers designated to be retrofit (3 already shipped)
- 10 Tablet computers acquired, software customized, installed, and users trained
- 244 Inspections completed using tablet computers, including many with pictures and notes
- 6 Infrared imaging cameras purchased and users trained
- 549 Infrared checks completed and entered into Ivara asset management software
- 300+ Network protector relays replaced as part of SCADA project
- 5 SCADA Gateways installed, 6 more to be completed by end of 2013-Q2 (allows monitoring NP's)
- 153 Steam-related work orders entered and all completed except recent entries still being worked
- 35 (of the 153) steam-related W.O.'s were generated by new information from Citizens Thermal
- 13 Network protectors tested for toluene gas. All were found acceptable, so it is safe to operate without venting.
- 84 Network-related equipment incidents entered into new failure database on new forms
- All (5) Networks modeled on CYME computer modeling program (proven accurate in modeling recent actual fault)

Sections 3 and 4 of this report provide supporting details confirming the IPL response to O'Neill Consulting recommendations is appropriate and complete. Those sections also provide details confirming that IPL satisfied the commitments to the IURC that are due in 2012. Appendix A provides the Gantt chart from the original commitment document with a new percent complete column.

### 3. Tier I recommendation completion results

The O'Neill Consulting report made ten recommendations grouped in two tiers based on emphasis needed. Five recommendations, #1 - #5, were grouped into Tier I and identified as "highest emphasis." Recommendations #6 - #10 were grouped into Tier II with lower emphasis. Section 2 of this report provides details for the Tier I recommendations. It contains two summary tables and five detailed subsections. Each of the five subsections describes one detailed O'Neill Consulting recommendation, the status of the recommendation, and how IPL completed the work. All recommendations and commitments are in italics. Actions related to the recommendations are in normal text. A complete list of IPL commitments is in Appendix A.

Table 3-1 below summarizes IPL status with respect to the specific details of the O'Neill Consulting Tier I recommendations.

IPL made specific commitments with respect to the O'Neill Consulting recommendations. Some of these commitments were above and beyond the specifics in the O'Neill Consulting recommendation. Table 3-2 on the next page provides a summary of each commitment and status. In some cases, IPL committed to future updates on a few specific activities. Those are identified in the right hand column of Table 3-2. They are also carried forward to Section 6.

Recommendation	Status related to O'Neill recommendation
1 - Citizens Energy Coordination	Complete
2 - Enhanced inspections	Complete
3 - Material standards	Complete
4 - Network protectors and transformers	Complete
5 - Asset management	Complete

Table 3-1 Tier I O'Neill recommendations completion status

<b>Recommendation</b>	<b>IPL Commitment</b>	<b>Status related to IPL commitment</b>
1 - Citizens Energy Coordination	Address manholes too hot to inspect	Complete
	Inspect manholes after heat is mitigated	Complete
	Create ongoing coordination and communication	Complete and continuing
	Replace damaged cables	Complete and continuing
2 - Enhanced inspections	Inspection procedure	Complete and continuing
	Audits of inspection	Complete and continuing
	Continuous improvement	Complete and continuing
	Use tablet computers for inspection	Complete and continuing
	Track repairs	Complete and continuing
3 - Material standards	Adjust standard for termination chambers	Complete
	Begin retrofit	Started and continuing
	Install deflector shields	Complete
	Report effectiveness of standards change and shields	Provide report, due in 2013
4 - Network protectors and transformers	Identify aluminum bus	Complete
	Sample 33% of identified with aluminum bus	Complete
	Inspect and pressure test where evidence of water ingress	Complete by deflector shield strategy
	Pressurize protectors after opened	Complete by deflector shield strategy
	Toluene gas and venting work practice change	Essentially complete: Formal practice change to be issued with completion of SCADA
	Seal or replace protectors that will not hold pressure	Complete by deflector shield strategy
	Report 2013 and 2014 replacement volume	Provide reports for 2013 and 2014
5 - Asset management	Additional resources and process	Complete - additional report due at the end of 2013
	Cable failure database	Complete and continuing
	Ivara software	Complete and continuing
	Failure reporting to IURC	Complete and continuing
	Update cable root cause procedure	Complete
	Condition and impact based maintenance and replacement	Complete and continuing

Table 3-2 Tier I IPL commitment completion status



### **3.1. Recommendation #1: Citizens Energy Coordination**

*Immediately identify and address, presumably through coordination with Citizens Energy, all manholes that have been too hot to safely enter and inspect. After mitigating the heat, inspect the holes, including measuring the current in all secondary leading from each such manhole. Where necessary, replace cable that has been significantly damaged by the heat.*

#### **3.1.1. Implementation status**

As of December 31, 2012 IPL completed Recommendation #1.

IPL completed all specific commitments related to recommendation #1. New business practices developed as part of the commitments will continue to improve.

Citizens Energy responded appropriately in the way IPL described in the IPL commitment response.

#### **3.1.2. Accomplishments**

**Citizens historical data** - On January 13, 2012 Citizens Energy provided IPL 10 years of historical data with a list of locations of steam system anomalies. IPL used the Citizens Energy information to create a map of the steam anomalies' in relationship to IPL electric manholes.

**Citizens leak survey results** - Citizens Energy provided IPL a copy of their 2012 Leak Survey results. IPL identified the areas where Citizens observed elevated temperatures and the proximity to IPL electric manholes. IPL field crews surveyed those locations for possible issues. No immanent issues were identified.

**Monthly meetings** - In February 2012 IPL and Citizens Energy instituted monthly meetings between operating and engineering personnel to review the prior month's steam anomaly report and any other coordination issues between the two companies. These meetings have been expanded to include not only the Citizens Steam operations, but chilled water, water, sanitary sewer, storm sewer, and natural gas operations. These meetings will continue through 2013 and beyond. Figure 3-1 shows a sample of meeting minutes from these monthly meetings.

**Coordination with Citizens** - The working relationship between Citizens Energy and IPL has grown and improved through regular intercompany meetings. Coordination and the flow of information between the two companies have improved in both electronic and verbal communications.

Citizens corrected a number of hot manhole issues. IPL has notified Citizens of some hot holes and followed-up.

**MONTHLY COORDINATION MEETING  
BETWEEN IPL & CITIZENS ENERGY  
MEETING MINUTES  
December 20, 2012**

- **Introductions**

Those in attendance included:

- **IPL**

- Jim Wernke – Director, Strategic Accounts & marketing
- Greg Micheel – Manager, Customer Solutions
- Mike Holtsclaw – Director, Engineering & Compliance
- Rick Leffler – Section Leader, Major Underground Projects

- **Citizens Thermal**

- Bob Purdue – Director, Thermal Operations
- Ed Malone – Director, Water Production
- Mark Vogler – Director, Asset Management
- Paul Dicken – Director, Water Distribution Operations
- Jamie Dillard – Director, Wastewater Operations

- **Review of Minutes from November 15, 2012 meeting**

*Reviewed the minutes from November 15, 2012 and were approved as issued, no changes*

- **Review and Discuss monthly Anomaly report**

- *November anomaly report.*

*Status of the following Steam projects*

- *119 W Market - done*
- *Delaware & North - Complete*
- *1 E Maryland – Complete*
- *23 E Maryland – Complete*
- *West & Gardner Lane - Lids changed and everything is okay, IPL was checking steam lids*
- *Georgia & Meridian - Maybe another insulation issue, common wall between facilities.*

**Figure 3-1 Portion of minutes of coordination meeting**

**Intercompany communication** - An email list was developed that is used to send an email to operations and engineering personnel at Citizens Energy (water, sewer, gas, steam) and IPL. It is used to make notifications of issues requiring attention between the two companies.

An example of how the system is used occurred in late December 2012. IPL received a report of a possible flooded manhole. IPL initiated the notification on December 19, 2012 at 4:21 PM for clear water flowing out of a manhole on north side of Court St. and the west side of Meridian. Citizens responded by 4:45 PM sending crews to investigate and repair. IPL and Citizens Energy personnel went to the scene to assess the situation. It turned out the manhole was not IPL's but was a city festival lighting hand-hole and the water was just surface water that had drained onto the cover. Though no action

was required by either company, this example illustrates how the process caused a prompt response by both companies.

**Steam issues addressed** - IPL issued 153 maintenance work orders in EMPAC that referenced steam in manholes or vaults between January 1, 2011 and December 31, 2012. All but 9 are complete with most of the incomplete work issued recently. Thirty-five of these work orders arose from Citizens steam reports.

**Less cable and splice failures** - The number of primary cable and splice failures dropped significantly in 2012 when compared to 2011. This improvement is especially noteworthy considering the greater stress from the 2012 heat wave. Figure 3-2 shows the ten year trend only for primary cable and splice failures.

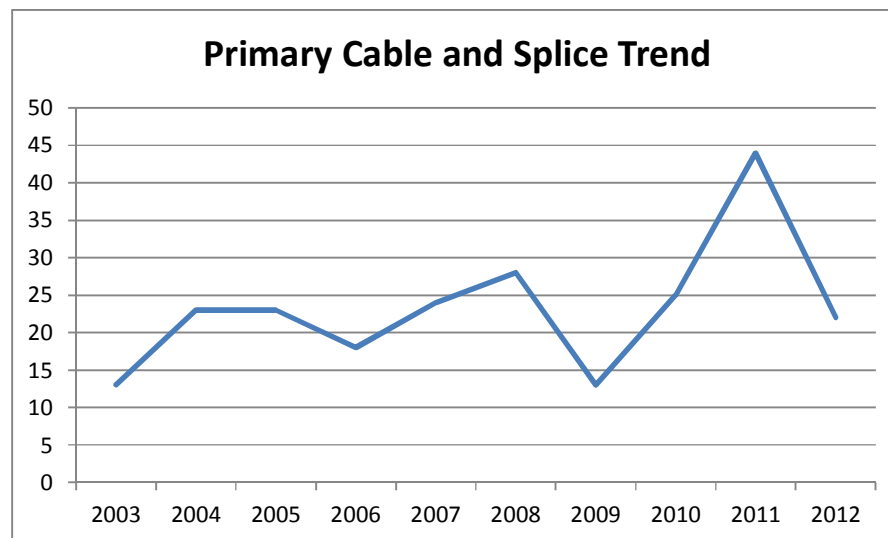


Figure 3-2 Primary cable and splice failure trend

### 3.2. Recommendation #2: Enhanced Inspections

*Improve the program of inspection and repair of manholes and vaults, re-focusing the work force on finding not just conditions indicative of imminent failure but also those that might cause excessive stress or might lead to a failure under some not unlikely circumstances. Furthermore, do the repairs indicated by such an enhanced program of inspection.*

#### 3.2.1. Implementation status

As of December 31, 2012 IPL completed Recommendation #2.

IPL satisfied all individual commitments related to this recommendation. New business practices developed as part of the commitments will continue to improve.

#### 3.2.2. Accomplishments

**Substantial process improvement** - IPL has made considerable improvements in its inspection process for manholes and vaults. The inspection forms have been improved and the data is now captured electronically on the tablet computer and uploaded into IPL's Asset Management software. Depending on the technician's response to certain questions on the inspection form, the crew may be prompted for additional information or to take a picture of the item being inspected. Pictures have proven to be useful when reviewing the inspection results back in the office.

**Aggressive inspection frequency** - The inspection frequency has been accelerated. Manholes are on a 3 year cycle and vaults are on a 2-year cycle.

**Audit of inspection** - On November 13-14, 2012, O'Neill consultants were on-site at IPL to conduct spot checks of manholes and vaults that IPL had inspected. The purpose of these audits was to confirm quality of the inspections being performed by IPL crews. The results of the spot checks were satisfactory and showed that IPL crews are now doing a much better job of catching longer term issues not just those that are an immediate threat. This was a key issue in the O'Neill Consulting report.

**Infrared** - Each IPL Network crew that performs manhole inspections has been equipped with a portable thermal imaging camera.

**Tablet computer inspections** - All IPL network crews are using the tablet computers for manhole inspections to capture data and pictures. A more detailed description is in Section 4.1.2 in response to recommendation #6.

**Special manhole inspection and repairs** - IPL completed the special inspection of 1,351 manholes in 2011. This special inspection generated 509 maintenance work orders to make repairs. The repairs included capping or pulling idle cable, fixing leaking splices, identifying steam issues, re-racking cables and other maintenance issues. In some cases, the inspection led to engineering structural reviews with associated capital repair projects. All but 1% of the maintenance repair work orders are complete. The remaining 1% will be complete within the next two weeks. Structural reviews were also performed with repairs either complete or prioritized and planned in the capital budget. All of the work is entered and tracked to completion in IPL work management systems.

**Vault review** - A 2011 review of vault inspection records generated 15 follow-up maintenance work orders and 19 structural reviews by engineering. All of the maintenance work is complete. The structural reviews are also complete with repairs either complete or prioritized and planned in the capital budget. All of the work is entered and tracked to completion in IPL work management systems.

**Prioritization** - All of the manholes in the Central Business District (CBD) have been graded by importance. IPL conducted internal meetings with key decision makers to agree on priority ranking. This criticality rating is based on seven factors. In the table below are the agreed rating factors along with their assigned value.

Manhole Criticality Ratings	
INDICATOR	Priority Rating (1 to 10) 10 most urgent
MH - Criticality History of Steam	8
MH - Criticality Vented Cover	1
MH - Criticality Primary Circuits (3 or more)	3
MH - Criticality Secondary Circuits (3 or more)	5
MH - Criticality Secondary 500MCM	7
MH - Criticality Previous Fault	4
MH - Criticality High Traffic Area	2

Table 3-3 Manhole criticality ratings

These seven indicators are used in Ivvara (Asset Management Software) to help direct follow up work in conjunction with the previously described calculated condition indicator. During the fourth quarter of 2012 these criticality ratings have been used to prioritize manhole inspections directing the inspection to the more critical manholes.

These criticality ratings have also been used to identify the manholes where an additional 50 Swiveloc™ manhole restraint covers were installed in 2012.

**Ivvara issuing follow up work orders** - The new process using tablet technology through Ivvara to EMPAC generated 244 maintenance work orders as of December 31, 2012. Table 3-4 summarizes the orders issued and progress. Low priority numbers are more important with Priority 1 being the most important. It should be noted that Priority 1 and Priority 2 work would generate an emergency EMPAC work order for repairs. The inspection report in Ivvara would normally show the work already complete. Priority 6 is the least important and may be completed when convenient to do with other work on the asset.

Priority	In progress	Complete	Grand Total
Priority 3	1	15	16
Priority 4	43	25	68
Priority 5	99	48	147
Priority 6	13		13
Grand Total	156	88	244

Table 3-4 Ivvara Repair order summary

**Improved inspection process** - IPL significantly improved the inspection process. Inspection findings are clearly visible to responsible IPL employees from initial inspection until repairs are complete. Figure 3-3 through Figure 3-7 show various stages of the enhanced inspection process. The steps include gathering data on the tablet, data visibility, data assessment in Ivvara, and work generation based on IPL business rules.

Inspections are easy to perform, easy to record, and remain in the queue until repaired. The data remains in the system for trend analysis after completion.

Figure 3-3 shows how inspection data is available by way of Mobile Frame on the Asset Management web. Notice the highlighted area for manhole MHI-13-97. Users may click on the link to see details depicted in Figure 3-4 on the next page.

IPL POWER DELIVERY ASSET MANAGEMENT				
<a href="#">Home</a> <a href="#">Reliability</a> <a href="#">EMPAC</a> <a href="#">CBD</a> <a href="#">WMIS</a> <a href="#">MobileFrame</a>				
Asset Type:				
<input checked="" type="radio"/> Manhole <input type="radio"/> Vault <input type="radio"/> Network Transformer <input type="radio"/> Network Protector				
Asset #:	<input type="text"/>	<input type="button" value="Search"/>		
<a href="#">View</a>	Asset #	Asset ID	Inspection Started	Inspection Finished
<a href="#">View</a>	MHK14-96	MHK14-96	1/10/2013 12:02:19 PM	1/10/2013 1:25:20 PM
<a href="#">View</a>	MHI42-01	MHI42-01	1/9/2013 1:34:24 PM	1/10/2013 11:01:43 AM
<a href="#">View</a>	MHM21-98	MHM21-98	1/9/2013 12:30:13 PM	1/9/2013 12:44:38 PM
<a href="#">View</a>	MHM31-06	MHM31-06	1/9/2013 11:21:47 AM	1/9/2013 11:57:07 AM
<a href="#">View</a>	MHM21-97	MHM21-97	1/9/2013 10:16:47 AM	1/9/2013 10:36:23 AM
<a href="#">View</a>	MHM31-11	MHM31-11	1/9/2013 9:50:09 AM	1/9/2013 10:02:18 AM
<a href="#">View</a>	MHM31-10	MHM31-10	1/7/2013 1:28:12 PM	1/7/2013 1:57:49 PM
<a href="#">View</a>	MHM31-04	MHM31-04	1/7/2013 12:35:05 PM	1/7/2013 1:28:09 PM
<a href="#">View</a>	MHM31-00	MHM31-00	1/7/2013 11:30:05 AM	1/7/2013 12:35:02 PM
<a href="#">View</a>	MHI23-01	MHI23-01	12/31/2012 11:44:03 AM	12/31/2012 11:51:39 AM
<a href="#">View</a>	MHM21-10	MHM21-10	12/17/2012 12:48:15 PM	12/17/2012 2:20:34 PM
<a href="#">View</a>	MHM21-11	MHM21-11	12/17/2012 10:04:13 AM	12/17/2012 11:20:46 AM
<a href="#">View</a>	MHM21-19	MHM21-19	12/15/2012 1:02:47 PM	12/15/2012 1:12:40 PM
<a href="#">View</a>	MHM21-20	MHM21-20	12/15/2012 12:49:28 PM	12/15/2012 12:50:31 PM
<a href="#">View</a>	MHM21-09	MHM21-09	12/14/2012 12:34:34 PM	12/14/2012 12:57:25 PM
<a href="#">View</a>	MHM21-05	MHM21-05	12/14/2012 10:11:37 AM	12/14/2012 10:33:42 AM
<a href="#">View</a>	MHI12-03	MHI12-03	12/11/2012 12:44:42 PM	12/11/2012 12:51:18 PM
<a href="#">View</a>	MHM21-03	MHM21-03	12/11/2012 11:21:28 AM	12/11/2012 11:55:58 AM
<a href="#">View</a>	MHM11-97	MHM11-97	12/11/2012 11:05:56 AM	12/11/2012 11:42:27 AM
<a href="#">View</a>	MHI13-97	MHI13-97	12/11/2012 10:11:19 AM	12/11/2012 10:40:50 AM
<a href="#">View</a>	MHI22-92	MHI22-92	12/11/2012 9:47:26 AM	12/11/2012 10:04:42 AM
<a href="#">View</a>	MHM21-04	MHM21-04	12/10/2012 1:14:15 PM	12/10/2012 2:06:46 PM

Figure 3-3 Asset Management web view of tablet inspection results

Clicking on the view button for manhole MHI13-97 from the previous screen reveals the detailed inspection results. Notice two highlighted areas in Figure 3-4. The lower highlight shows the technician made the correction while on site. The upper highlight is a hyperlink to the photograph taken by the technician.

**IPL POWER DELIVERY ASSET MANAGEMENT**

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Asset #	MHI13-97
Asset ID	MHI13-97
Inspection Type	Manhole Inspection
Inspection Started	12/11/2012 10:11:19 AM
Inspection Completed	12/11/2012 10:40:50 AM
Able to Complete	Yes

Question	Response	Repaired	Photo	Notes
Check Manhole - Cover	Normal - Solid			
Check Manhole - Ring	Normal			
Check Manhole - Steam	Normal - No steam issues			
Check Manhole - Flooding	Normal condition - dry			
Check Manhole - Debris	Normal condition			
Check Primary Cable	Normal			
Check Primary Cable - Splice Cases	Normal - No leaking			
Check Secondary Cable	Normal			
Check Secondary Splices	Damaged or oil seeping	No	<a href="#">View</a>	north wall old leak need to replace wyes with straights....south wall old leak wye splices
Check Secondary Splices	Damaged or oil seeping	No	<a href="#">View</a>	north wall old leak need to replace wyes with straights....south wall old leak wye splices
Check Secondary Current	Normal			
Check Ground or Neutral Cables	Normal - No problems found			
Check Manhole - Cable Racks	Normal Condition			
Check Manhole - Cable Support	Normal - Adequate			
Check Asbestos	No			
Check Primary Cable - ID Tags	Missing or unable to read	Yes	<a href="#">View</a>	d6 east ug 451 just need an additional tag added off the wye splice

Figure 3-4 Detailed results from previous screen showing picture link and on-site repairs

The photograph of the problem is Figure 3-5. Also notice the technician wrote a small note on the figure adding information about the location of the problem. The technician wrote the note using the tablet computer.



Figure 3-5 Handheld tablet picture with technician note on picture



Tablet computer data uploads to Ivara. Ivara follows IPL business rules for condition and impact of the reported problem. Business rules in Ivara calculated a condition indicator and issued an alarm for manhole MNI13-97. Figure 3-6 shows the Ivara indicator screen with an important portion of the screen expanded for easier reading. An IPL employee acknowledged the alarm and issued EMPAC Work order 12-046223-000 to make repairs.

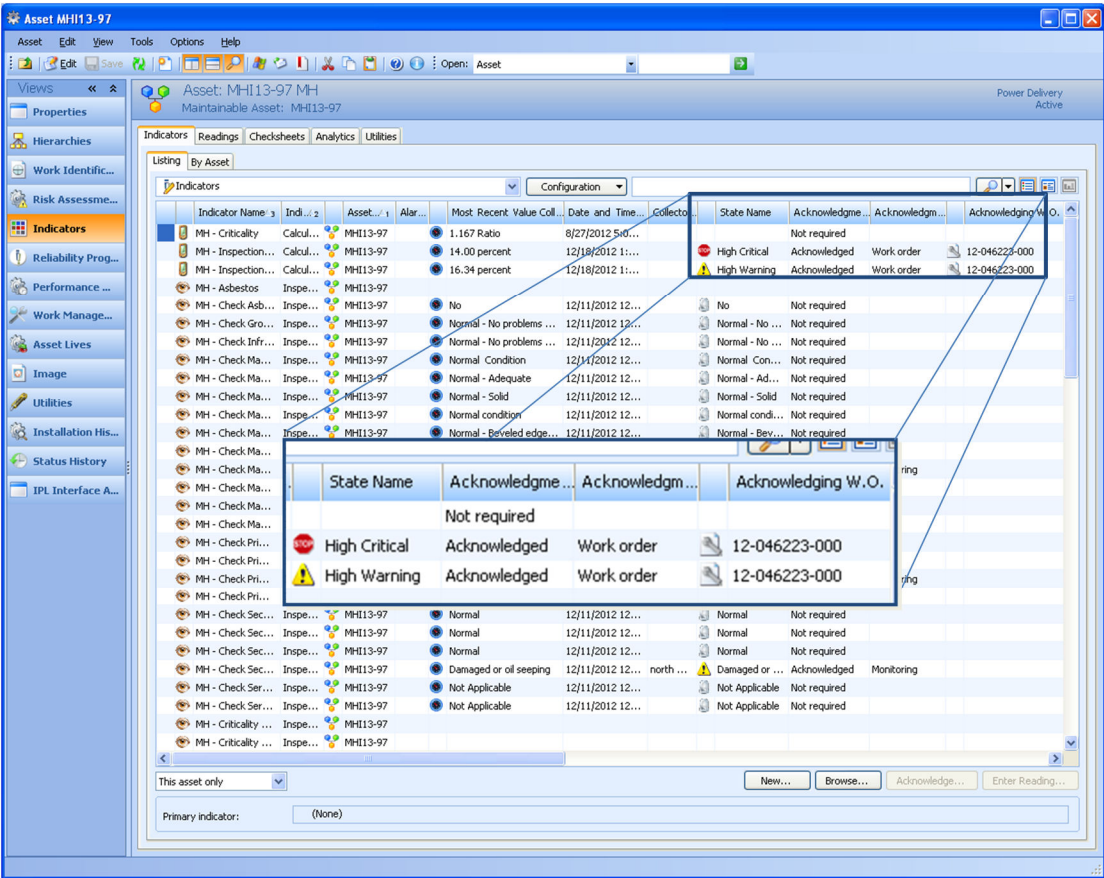


Figure 3-6 Acknowledged alarm and work order reference in Ivara

Here is work order 10-046223-000 in the EMPAC asset and work management system. Note the arrow pointing to 14.00% importance reading from Ivvara carried through to EMPAC. Additional details of the work needed carry through to the description. This gives the scheduler guidance on the priority of the work. The 14.00% reading generated a priority 5 rating based on IPL business practices.

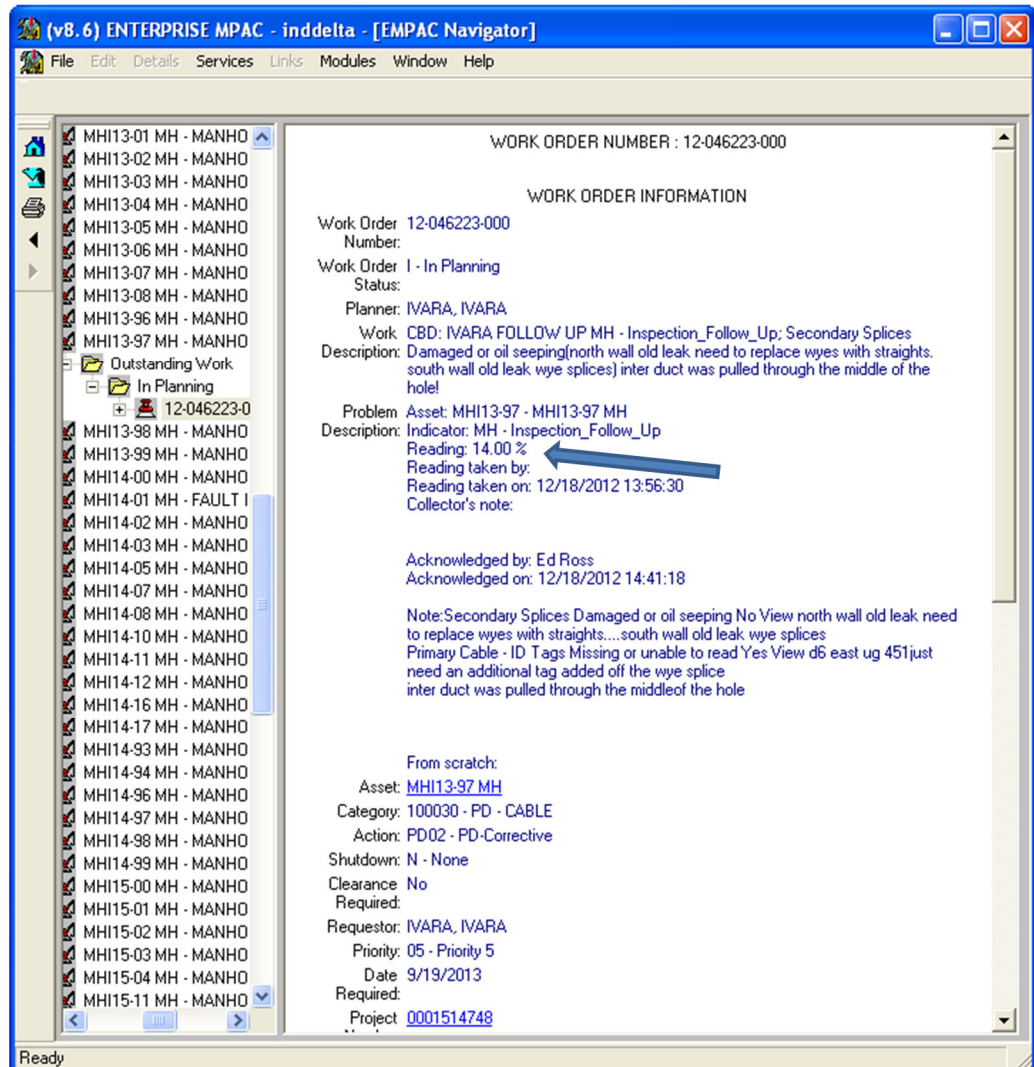


Figure 3-7 Work order as it appears in work management with indicator

Table 3-5 shows two summaries of work orders with higher priority. The description provides information about the problems found. It also shows the results of the criticality calculation based on condition and location. Both of these work orders have higher follow up ratings and higher priority for completion. Both work orders are complete.

Work order	Asset	Priority	Description	Complete
12-012717-000	MHM11-03	Priority 3	CBD: IVARA FOLLOW UP: MH - Inspection_Follow_Up is 33.00 percent (High Critical). Racks need porcelain, need new racks, off the wall, missing; Duct Mouth - Very rough edges; (UG 701 on the floor; UG 432 leaking splices); Idle cable not capped	Y
12-035054-000	NTRMOP690510	Priority 3	CBD: IVARA FOLLOW UP: Vault - Network_Transformer_Inspection_Follow_Up is 23.00 % (High Critical) Check Network Transformer - Rust - Some rust/Transformer Main Tank - Oil Level-No oil level detected/Switch Chamber - Oil Level - Oil level high	Y

Table 3-5 Ivvara repair order examples

### **3.3. Recommendation #3: Material Standards**

*Begin a program of retrofitting termination chambers with elbow fittings, and specifying such equipment for new or replacement network transformers. Also, protect the tops of network transformers with deflector shields, and specify corrosion-resistant tops for new transformers.*

#### **3.3.1. Implementation status**

As of December 31, 2012 IPL completed Recommendation #3.

IPL completed all commitments related to this recommendation. One additional report on the effectiveness of changes to standards and effectiveness of the shields will be due at the end of 2013.

#### **3.3.2. Accomplishments**

**Material specifications revised** - IPL has revised the material specification for its network transformers to eliminate the termination chamber and now include bushing wells for use with a bolted primary termination. The specification was also changed to now include FR3 fire retardant insulation fluid in all transformer compartments to reduce the risk of fire in the event a catastrophic transformer failure.

**New specifications in service** - IPL has taken delivery of 6 new transformers using the new material specification.

IPL has installed one of the new transformers using the bolted primary termination. Going forward this will be the standard for any transformer installed in a vault whether it's a new installation or a replacement of an existing unit.

IPL will retrofit 18 brand new units already in stock having the old termination chamber design to the new bolted termination design. It will take the manufacturer approximated 6-9 months to complete this retrofit work. Three units have already been shipped to the vendor for modification.

**Deflector shields** - IPL completed the installation of 154 deflector shields over network transformers. The planned goal was to do 100 units by the end of 2012. IPL greatly exceeded that goal. All planned installations are complete. Figure 3-8 shows a deflector shield example.

**Additional deflector shields** - IPL identified additional vault units that require a deflector shield installed over the network transformer. These installations are complete and part of the additional 54 units installed prior to December 31, 2012.

IPL and O'Neill Consulting reviewed the costs and benefits related to the use of corrosion resistant tops. Both parties agreed corrosion resistant tops are not cost effective for IPL. The deflector shields address the debris issues associated with corrosion on the tops of the transformers. These are also part of the 54 additional units over and above the initial commitment of 100 shields.

**Deflector shields over aluminum bus** - Deflector shields were installed on 18 of 20 network transformers that have network protectors with aluminum bus. Deflector shields are an agreed upon alternative solution for network protectors with aluminum bus. (See Recommendation 4, Section 3.4.2 of this report.). Eighteen of the 20 shields are in service. The two remaining shields will be installed after planned repairs to the vault structure. The structure repairs are underway.

### **3.4. Recommendation #4: Network Protector & Transformers**

*Begin a program of replacement of certain failure-prone network protectors, such as those with an aluminum bus, and also those that show evidence of water ingress despite being designed to be submersible. In some cases, a simple repair may suffice to remediate the latter condition. Continue to replace network transformers and network protectors found to be in such poor condition that failure is likely.*

#### **3.4.1. Implementation status**

As of December 31, 2012 IPL completed Recommendation #4.

IPL completed the intent of the commitments associated with this recommendation. Pressure testing proved more difficult than IPL and O'Neill Consulting anticipated. The accomplishment section below describes how IPL and O'Neill Consulting worked together to develop an alternate shielding plan.

IPL committed to report on replacement quantities for year-end 2013 and 2014.

#### **3.4.2. Accomplishments**

**Replace protectors** - During 2012 IPL replaced 7 network protectors, one of those that was replaced did have corroded aluminum bus.

**Aluminum bus identified** - IPL believes it has identified all network protectors with aluminum bus. This was done using information from the manufacturer and field checking the size of the bus in a number of network protectors.

**Alternate plan developed for pressurization** - IPL has encountered a number of issues in trying to pressure test network protectors, with a focus on those identified as having aluminum bus. Even after replacing the door gasket material the network protectors still will not hold pressure. IPL has discussed this issue with O'Neill Consulting and the new course of action is to install deflector shields above these units. IPL is also investigating installing a moisture sensor either in the vault or in the network protector to detect a potential moisture problem and allow time for corrective action to be taken. Figure 3-8 shows an example of the deflector shield. A total of 25 shields were installed for this particular reason.



Figure 3-8 Debris captured by Deflector Shield

**Toluene gas** - Testing for toluene gas in certain network protectors was completed and the results have been reviewed by IPL's Safety group. The levels of toluene gas found were well within acceptable limits. This will allow the practice of venting network protectors before manually operating them to be discontinued. This work practice is scheduled to be changed in 2013 after the Network SCADA project is fully operational.

### 3.5. Recommendation #5: Asset Management

*Improve the process of asset management by dedicating additional resources to development of equipment databases and processes that facilitate effective failure analysis and resource planning for condition-based equipment maintenance and replacement that goes beyond imminent failure.*

#### 3.5.1. Implementation status

As of December 31, 2012 IPL completed Recommendation #5.

IPL has completed all specific commitments associated with this recommendation. New business practices developed as part of the commitments will continue to improve.

One additional status report on asset management staffing and process implementation is due at the end of 2013.

#### 3.5.2. Accomplishments

**Resources and structure** - IPL added a full time engineering position to the Asset Management Department and continues to use the services of an outside contractor for asset management support. IPL has documented roles and responsibilities for the Asset Management Department that includes setting maintenance guidelines, setting inspection guidelines, monitoring program effectiveness, reviewing programs annually, conducting audits, and performing other responsibilities normally associated with centralized asset management structure. This organizational structure, combined with additional resources, will improve IPL's asset management for all T&D assets including the network assets.

**Network failure analysis** - A new failure reporting form and database is in place for network failure events. The new database improves ease of storage and analysis. The database shows better performance in 2012 compared to 2011. There were 52 failure events (including primary cable, secondary cable, splices, transformers, etc.) in 2011 and 30 recorded events in 2012.

**Strategic planning** - The new asset management engineer used the new failure data base to determine the need for a network primary cable replacement program. IPL now has a ten year strategic plan and budget for proactive cable replacement based on cable performance, condition and failure impact.

A similar analysis re-directed resources away from lower priority work. Some time ago, a series of failures led to a replacement program for certain wye splices on substation exit cables. Monitoring of ongoing failures showed the series of failures actually did not indicate growing problems. The analysis justified directing resources to higher priority work.

**Condition and impact** - The IPL Asset Management group conducted a number of meetings with subject matter experts and leadership to assign the priority scoring based on inspection conditions found and failure impact. This provides a consistent approach supported by all who are involved in maintaining asset condition. IPL provided a detailed description of IPL risk and asset management decision making on December 15, 2012.

**Program review** - IPL Asset Management is responsible for reviewing all T&D inspection and maintenance programs annually. The 2012 review is complete. It exceeded the basic requirement by including capital replacement programs as part of the review. Asset Management made improvements to maintenance as well as capital programs.

**Downtown failure reporting** -IPL reports downtown network events by email in the same way it reports major storms to the IURC.

**Ivara software** - IPL completed the automatic loading of network inspections into Ivara. IPL is further leveraging Ivara software by adding dissolved gas in oil analysis (DGA), ductor contact resistance readings, overload and other information in Ivara. IPL is expanding inspection information to include substation inspections in Ivara as well.

**Continuous improvement** - IPL has the procedures and processes in place to annually update asset management strategies.

**Additional information** - IPL provided IURC Staff detailed information with respect to additional improvements in asset management. That information on work management, root causes, and risk management arose from separate data requests. The information is in IPL October 19, 2012 responses to those requests.

**Root cause procedure** -IPL implemented a process to capture detailed information from every fault event that occurs on the network system. The data collection begins with the field personnel filling out the Network Failure Analysis form. The form is then reviewed by Asset Management and is then forwarded to Engineering for their review and posting in the Network Failure Database. Reports and analysis can then be done using the Network Failure Database to look for trends and other common factors.


Figure 3-9 shows the first page of a three page failure form used for the root cause analysis. Figure 3-10 shows the last page. All of the information goes into the failure database.



This is the first page of the failure form associated with IPL's root cause failure analysis.

2012/104-01

Page 1 of 3



**INDIANAPOLIS POWER & LIGHT COMPANY**  
NETWORK FAILURE ANALYSIS DATA FORM

Date of Event: 11/4/2012 Time of Event: 15:51

Location Address: Maryland & Meridian ST

Feeder Number UG 631

Description of Event: Steam Leak / In the process of making repairs

Substation:

Edison	
Gardner Lane	
Sub 3	

Initial Cause:

Fault	
Dig-in	
Flooding	
Steam Leak	X
Other	

Fault Location:

Manhole	
Duct line	X
Vault	

Network Area:

Edison East	
Edison West	
Gardner Lane North	
Gardner Lane South	X
Sub 3	
Non-Network	

What Failed:

Cable	X
Splice	
NW Protector	
NW Transformer	
Vault Bus	

IURC Reportable Event:

Yes	
No	X

Note: If the Answer to any of the 3 questions in Pink are Yes, this is an IURC Reportable Event

Were Flames or Smoke Visible Above Vault Grating:

Yes	
No	X

Manhole Number 1: K13-20 Manhole Number 2: V13-00

Last Inspected: 6/28/2011 Last Inspected: 6/28/2011

Manhole Temperature: 110/o Manhole Temperature: 112/o

Manhole Cover Type:

Solid	X
Stabiloc	
Vented	
Slotted	

Cover Dislodged:

Yes	
No	X
Unknown	

Manhole Cover Type:

Solid	X
Stabiloc	
Vented	
Slotted	

Cover Dislodged:

Yes	
No	X
Unknown	

NW Failure Analysis Report Version 2.4 Dated 12/20/2011

Figure 3-9 First page of failure form

This is the last page of the failure form associated with IPL's root cause failure analysis. Note the form is reviewed and signed.

Page 3 of 3

<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;">Network Protector:</td> <td>Failed to Open</td> <td></td> </tr> <tr> <td></td> <td>Failed to Close</td> <td></td> </tr> <tr> <td></td> <td>Relay Issue</td> <td></td> </tr> <tr> <td></td> <td>NWP Fuse Open</td> <td></td> </tr> <tr> <td></td> <td>Gasket Failure</td> <td></td> </tr> <tr> <td></td> <td>Catastrophic Failure</td> <td></td> </tr> </table>	Network Protector:	Failed to Open			Failed to Close			Relay Issue			NWP Fuse Open			Gasket Failure			Catastrophic Failure		<p>Inspection Date: _____</p> <p>NWP Serial Number: _____</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 70%;">Network SCADA:</td> <td>Yes</td> <td></td> </tr> <tr> <td></td> <td>No</td> <td></td> </tr> </table>	Network SCADA:	Yes			No	
Network Protector:	Failed to Open																								
	Failed to Close																								
	Relay Issue																								
	NWP Fuse Open																								
	Gasket Failure																								
	Catastrophic Failure																								
Network SCADA:	Yes																								
	No																								

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Oil Test Data

Oil Samples Taken:	DGA	
	Oil Quality	
	Other	
	None	

DGA Results:	Pass	
	Fail	

Oil Quality Results:	Pass	
	Fail	

Sample Number: \_\_\_\_\_ Sample Number: \_\_\_\_\_

Test Report Number: \_\_\_\_\_ Test Report Number: \_\_\_\_\_

---

Vault Data

Bay: \_\_\_\_\_

Last Inspected: \_\_\_\_\_

Vault Bus Fault:	Phase - GND	
	Phase-Phase	
	None	

Hi Cap Fuse:	Okay	
	Open	
	Failed	

Cause:	Tracking	
	Shorted	
	Flooding	
	Other	

Barrier Board:	Okay	
	Deteriorated	
	Failed/Flash Over	

Bus Issue:	Bus Bars	
	Insulator	
	Clamp	

Structure Condition	Excellent	
	Good	
	Poor	

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Additional Comments or Information


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Submitted By: <u>Mike Lee</u>	Date Submitted: <u>11/7/2012</u>
Reviewed By: <u>Ed Ross</u>	Date Reviewed: <u>11/9/2012</u>
Report Uploaded to Database By: <u>AMKAT</u>	Date: <u>11-12-12</u>

NW Failure Analysis Report
Version 2.4 Dated: 12/20/2011

Figure 3-10 Last page of failure form with signatures

## 4. Tier II recommendation completion results

The O'Neill Consulting report made ten recommendations grouped in two tiers based on emphasis needed. Five recommendations, #1 - #5, were grouped into Tier I and identified as "highest emphasis." Recommendations #6 - #10 were grouped into Tier II with lower emphasis. Section 4 of this report provides all of the details for the Tier II recommendations. It contains two summary tables and 5 detailed subsections. Each of the 5 subsections describes one detailed O'Neill Consulting recommendation, the status of the recommendation, and how IPL completed the work. All recommendations and commitments are in italics. Actions related to the recommendations are in normal text. A complete list of IPL commitments is in Annex A.

Table 4-1 below summarizes IPL status with respect to the specific details of the O'Neill Consulting Tier II recommendations.

IPL made specific commitments with respect to the O'Neill Consulting Tier II recommendations. Some of these commitments were above and beyond the specifics in the O'Neill Consulting recommendation. Table 4-2 on the next page provides a summary of each commitment and status. A few Tier II recommendation 6 commitments have been consolidated in Table 4-2 because they overlap with Tier I recommendation #5. In some cases, IPL committed to future updates on a few specific activities. Those are identified in the right hand column of Table 4-2. They are also carried forward to Section 6.

Recommendation	Status related to O'Neill Consulting recommendation
6 - Inspection technology	Complete
7 - SCADA project	Complete
8 - Small scale technology	Complete
9 - GIS mapping and modeling	Complete
10 - Oil testing and FR fluid	Complete

Table 4-1 Tier II O'Neill Consulting recommendation completion status

Recommendation	IPL Commitment	Status related to IPL commitment
6 - Inspection technology	Use tablet computers with business rules for inspection	Complete and ongoing
	Use Ivara software and upload from tablets	Complete and ongoing
	Evaluate option to show Citizens facilities on IPL tablets	Complete
	Review the inspection results, audit findings and inspection processes annually	2012 review is complete. Practices and procedures in place for future years
	Report results at the end of 2013 and 2014	Report results at the end of 2013 and 2014
7 - SCADA project	Update of deployment plan	Complete
	Review benefits, users, practices	Complete
	Publish final business practices	Third Quarter 2013
8 - Small scale technology	Thermal imaging	Complete and ongoing
	Fault detectors	Install on last circuit after proactive cable replacement
	Swiveloc <sup>TM</sup> lift/locking manhole covers in selected locations	Install complete - Report on effectiveness in 2014
9 - GIS mapping and modeling	Add CBD details to GIS map	Complete
	Build model of secondary network	Complete - incorporate use into Engineering design process
10 - Oil testing and FR fluid	Re-evaluate Dissolved Gas Analysis on network transformers	Complete
	Consider fire retardant fluid	Complete

Table 4-2 Tier II IPL commitment completion status

#### 4.1. Recommendation #6: Inspection Technology

*Evaluate technology for electronic capture of field inspection findings through the use of handheld devices, such as tablets, smart phones, or other means. Integrate this with recommendations 1), 2), and 5) above.*

##### 4.1.1. Implementation status

As of December 31, 2012 IPL completed Recommendation #6.

IPL has met all specific commitments associated with this recommendation that are due December 31, 2012.

IPL committed to report results using inspection technology at the end of 2013 and 2014.

##### 4.1.2. Accomplishments

**Tablet computers** - Tablet computers are in full use for network manholes, vaults, transformers and protectors. IPL uses the MobileFrame software to manage the interface on the tablet and to prepare the import database for Ivara. Ivara scripts import the data into Ivara for permanent records and for alarm processing. These tablet computers provide valuable support to IPL's enhanced inspection process described in Section 3.2.2. A series of four figures follow to provide more details about the tablet computer.

Figure 4-1 shows a technician performing an inspection with the tablet computer. The tablet requires the technician to positively report all results. Technicians must respond to each item on the inspection before moving to the next step. It allows the technician to write text descriptions of problems. It also allows technicians to take photographs with the tablet and to attach the photographs to the result.

Figure 4-2 is a sample of the tablet's internal inspection flow chart. For example, the requirement to visually check primary cable has three possible answers. 1) no primary cable, 2) normal condition or 3) damaged. The technician must report one of the three options in order to continue with the inspection. No primary cable bypasses the rest of the primary cable questions. Normal cable condition takes the technician to the primary splice condition checks. Damaged cable requires a) reporting affected feeders, b) taking photographs, and c) reporting if repairs were made during the inspection.



Figure 4-1 Technician inspecting with tablet

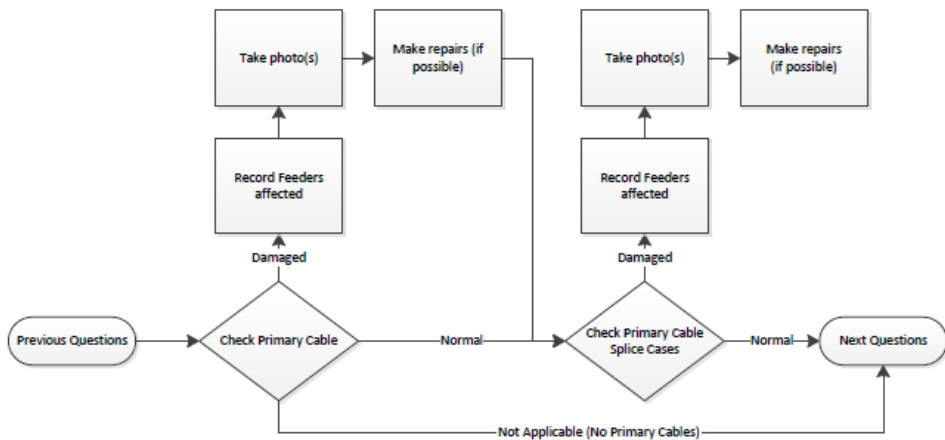


Figure 4-2 Sample section of tablet question flow chart

Technicians dock the tablets when they return to the office. They recharge and upload inspection results into the MobileFrame data base. Figure 4-4 shows a docked tablet.

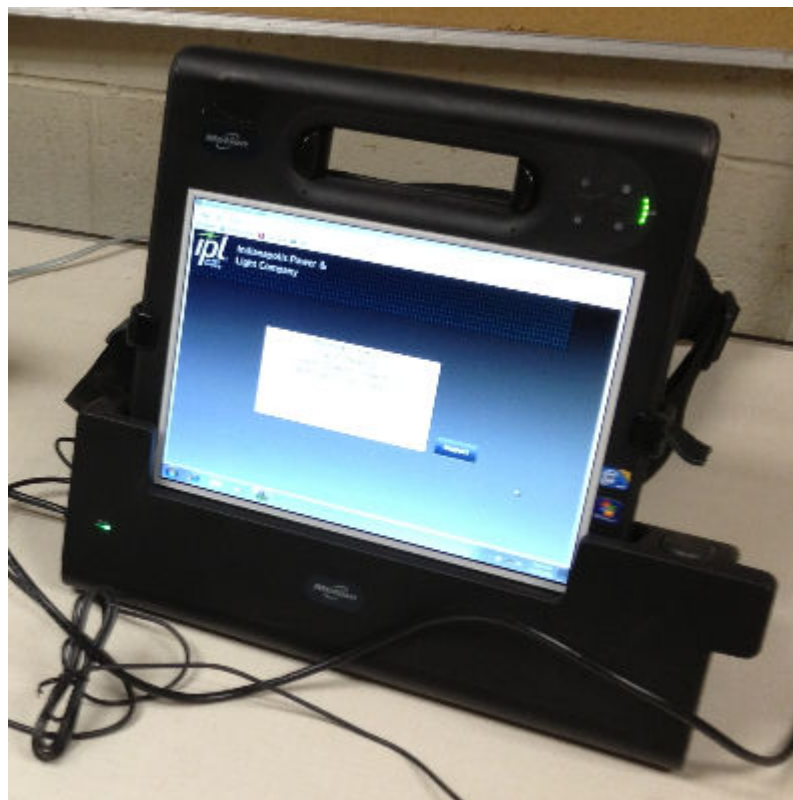


Figure 4-3 Docked tablet computer

Certain conditions warrant near immediate notification. MobileFrame checks the uploaded data against IPL condition notification criteria. MobileFrame generates an email alert when reported conditions exceed the notification threshold. Figure 4-4 shows a sample email alert from MobileFrame. The alert includes a text description of the problem and attaches any pictures the technician reported with the tablet computer.

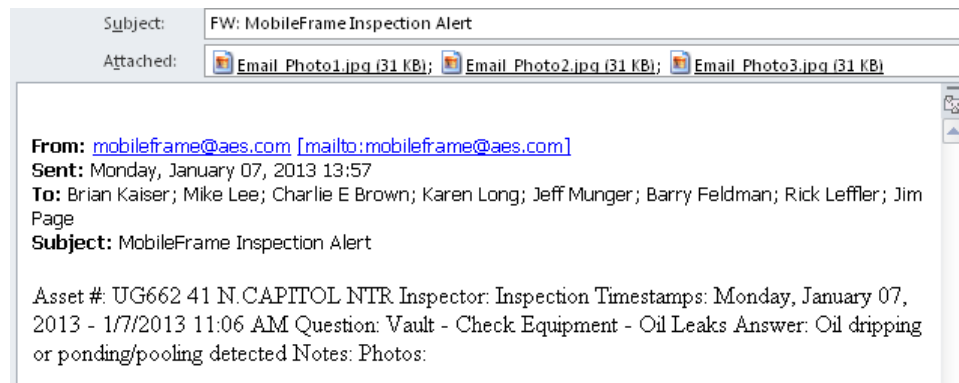


Figure 4-4 Sample email alert from MobileFrame

**Web application** - The IPL Asset Management group developed a web based application that allows easy viewing of the manhole inspection results. This was illustrated as part of the overall inspection process improvement in Section 3.2.2, Figure 3-3 and Figure 3-4.

**Expansion of tablet computer inspections** - IPL has a pilot program underway to expand the use of the tablet computer into substation inspections. Currently IPL's substation inspectors/switchmen use paper forms to do their quarterly inspections. By using the tablet the inspection form can be tailored to the substation being inspected and the data captured electronically and can then easily be uploaded to the asset management database.

**Citizens Energy visibility in GIS** - IPL evaluated options to make the Citizens Energy facility information available on the tablets. It was not practical to maintain Citizens Energy assets in IPL asset records. However, as a member of the Indianapolis Mapping and Geographic Infrastructure System (IMAGES) IPL is able to access information about Citizens Energy assets through that system.

## **4.2. Recommendation #7: SCADA Project**

*Re-examine the SCADA project, re-focusing on the data that such equipment will capture, and managing the stages of implementation so as to get benefits from even partial implementation as the project progresses.*

### **4.2.1. Implementation status**

As of December 31, 2012 IPL completed Recommendation #7.

IPL committed to completing additional training and to publishing final business practices in the 3rd quarter of 2013 after full deployment.

### **4.2.2. Accomplishments**

**Internal review** - IPL reviewed the data point list, screen displays, and usefulness of available data for network data in the Supervisory Control and Data Acquisition (SCADA) system. The final point list will improve safety, reduce operating costs and identify possible problems on the network. IPL will look for additional opportunities commensurate with additional network SCADA experience.

**Deployment plan** - The network SCADA is part of IPL's smart grid initiative with some financial support from the Department of Energy. When complete, the project will improve operability of the network. It will also enhance personnel safety by reducing the number of exposures to the vault environment. Five of the eleven gateways are in service. The remaining 6 will be in service by the end of the second quarter 2013. Delays were caused by technology limitations not known when the schedule was developed.

**Use of data** - Operators use the system to observe proper network protector operation. In one case, the SCADA showed a network protector was open when it should have been closed. Field technicians verified and solved the problem.

Other reports include a web page that is updated every 30 minutes showing the transformer/protector loadings. This is another quick way to identify overloads. A pumping report is also available. So far no pumping problems have been detected.



Figure 4-5 shows two sample SCADA screen shots for the network system. The upper right open/closed status is one place where an operator can quickly see open and closed protectors.

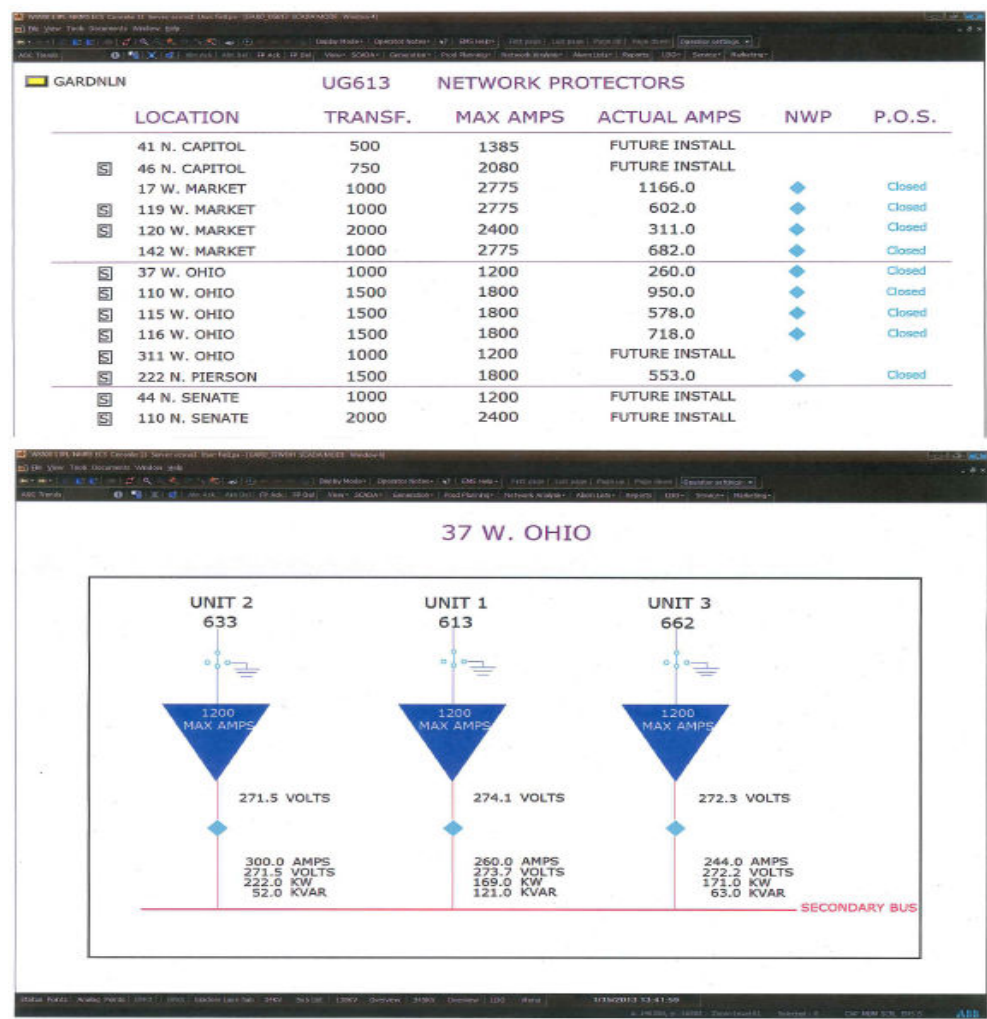


Figure 4-5 Two screen shots of network displays on SCADA

**Use of data in system planning** - The SCADA data is very useful to system planning and to operations. SCADA data is not only available to system operators. It also goes into the PI archive and retrieval data system. PI allows historical and real time displays. Figure 4-6 shows a real time display developed by system planning for their use.

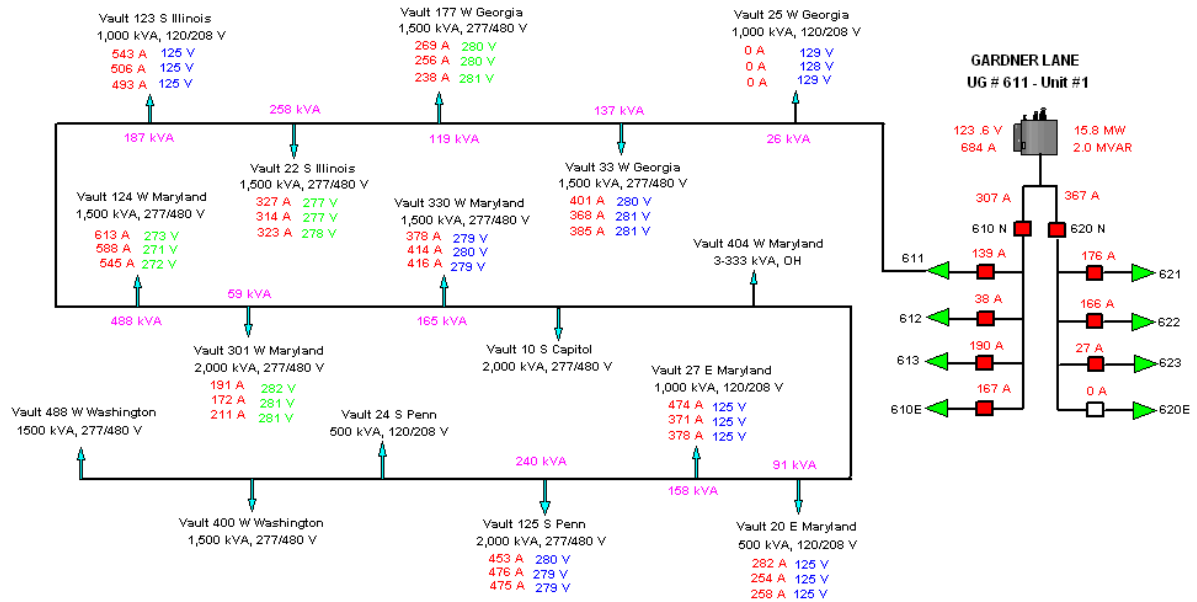


Figure 4-6 Sample screen from PI for network

#### **4.3. Recommendation #8: Small Scale Technology**

*Continue to deploy small-scale technological advances such as thermal imaging, fault direction indicators, and lift/locking manhole covers in selected locations.*

##### **4.3.1. Implementation status**

As of December 31, 2012 IPL completed Recommendation #8

IPL completed all commitments except for fault indicators on one circuit. They will be installed commensurate with a proactive cable replacement project already in progress.

IPL committed to inspect a sampling of Swiveloc™ covers for signs corrosion from road salts. Assuming no corrosion issues or other problems are encountered, additional Swiveloc™ covers will be installed in selected locations. IPL committed to preparing a report on the effectiveness of the Swiveloc™ cover in 2014.

##### **4.3.2. Accomplishments**

**Fault indicators** - Installation of the fault indicators was not completed prior to the end of 2012. This work was rescheduled to coordinate with other Smart Grid work that will be completed by the end of April 2013. Scheduling the needed network primary circuit outages to install the fault indicators was also a factor in delaying the final installations. Fault indicators are now installed on 43 of 44 circuits. Fault indicators will be installed on the 44<sup>th</sup> circuit when the cable is replaced. Cable replacement on this 44<sup>th</sup> circuit is part of IPL's practice cable replacement program and is already in progress. Figure 4-7 shows a fault indicator installed in a vault.

IPL has seen benefits from the primary cable fault indicator. The indicators have been used to quickly narrow down the section of the circuit the fault is located in, greatly reducing the amount of time test voltage is applied to the circuit to find the fault. In one instance the fault was located in less than 45 minutes, where without the fault indicator information it could take upwards of 6-8 hours to find a fault. In another case the circuit faulted and did not yet have fault indicators installed. The crew could not locate the fault. The fault indicators were installed and the substation breaker was closed. It immediately tripped out but the fault indicators tripped narrowing down the section of the circuit where the fault was located. This helped the crew to find the fault much faster than they otherwise would have.



Figure 4-7 Cable fault indicator

**Thermal imaging** - IPL purchased 6 thermal imaging cameras that are being used by the network crews that are doing manhole inspections. After the original trials, IPL purchased a higher grade thermal imaging camera for the crews. This new camera was easier to use and provides the ability to capture an image. Ivara records indicate 549 infrared checks on vaults and manholes since inception of the program. Less than 1% (four reports) indicate any reportable hot spots on equipment. One of the four reports relate to a steam issue.

**Swiveloc™ locking manhole covers** - IPL installed 152 of the Swiveloc™ locking manhole covers prior to the Super Bowl in February 2012. Another 50 Swiveloc™ manhole covers were installed in the fall of 2012 in high pedestrian traffic areas in the downtown area. Figure 4-8 shows a picture of a Swiveloc™ installation. To date IPL is not aware of a cable fault in a manhole with a Swiveloc™ cover. In the spring of 2013, a sampling of Swiveloc™ covers will be inspected for signs of corrosion from road salts. Assuming no corrosion issues or other problems are encountered in removing the covers after they have been exposed to the elements for a year, installation of additional Swiveloc™ covers in selected locations is planned.



Figure 4-8 SWIVELOC™ manhole cover installation

#### **4.4. Recommendation #9: GIS Mapping & Modeling**

*Continue to develop automated mapping/GIS data and applications for the downtown underground network, and develop models of secondary loads flows in the networks.*

##### **4.4.1. Implementation status**

As of December 31, 2012 IPL completed Recommendation #9.

IPL met all of the specific commitments associated with this recommendation. The commitments offered to provide status updates in meetings at the request of the IURC. The work is complete, so additional status updates may not be needed.

##### **4.4.2. Accomplishments**

**Data in GIS** - IPL completed digitizing all manholes, vaults, primary circuits, and all five secondary networks and the data is in production in IPL's graphical information system (GIS). This information is now available to IPL's engineers and the operations staffs for their use. This GIS data will now be maintained in place of the many paper map products previously used.

**Model built** - IPL completed the development of computer models of all five secondary networks in the CYME load flow and fault analysis computer program. The CYME software will be used to conduct fault studies and power flow analysis of the existing systems. Cyme will also be used to model improvements and additions to the network system. IPL will continue to enhance the use in the CYME tool for network design, configuration, and planning.

**Model verification** - IPL verified one part of the model by comparing measured primary fault current to modeled fault current. A fault occurred on the Gardner Lane network, and smart relays recorded the fault current. The exact location of the fault was modeled in CYME for comparison. The modeled results matched within 5% of the measured fault current. Additional future primary faults will be modeled to help confirm the accuracy of the model. Also IPL will compare measured load flows to modeled load flows. IPL confirmed the model is valid by inserting estimated loads on various points and instructing CYME to find a solution. CYME converged on solutions as expected. Model verification and maintenance is an ongoing process as changes and updates are made to the network system.

**Power Flow Analysis** - Figure 4-9 shows a screen shot of the overall system model in the CYME computer program. The black lines are the Medium Voltage primary system. The red lines are a portion of the Low Voltage secondary network. Work is continuing to incorporate metered customer load data with network SCADA load data, and feeder load data to improve power flow modeling. Completion of the Network SCADA project (Recommendation #7) will improve accuracy of the CYME model solutions. Use of power flow modeling in the engineering design process will allow primary and secondary cable loading to be analyzed for new load additions or when modifications to the network system are made. IPL will use the power flow analysis to make better network configuration decisions.

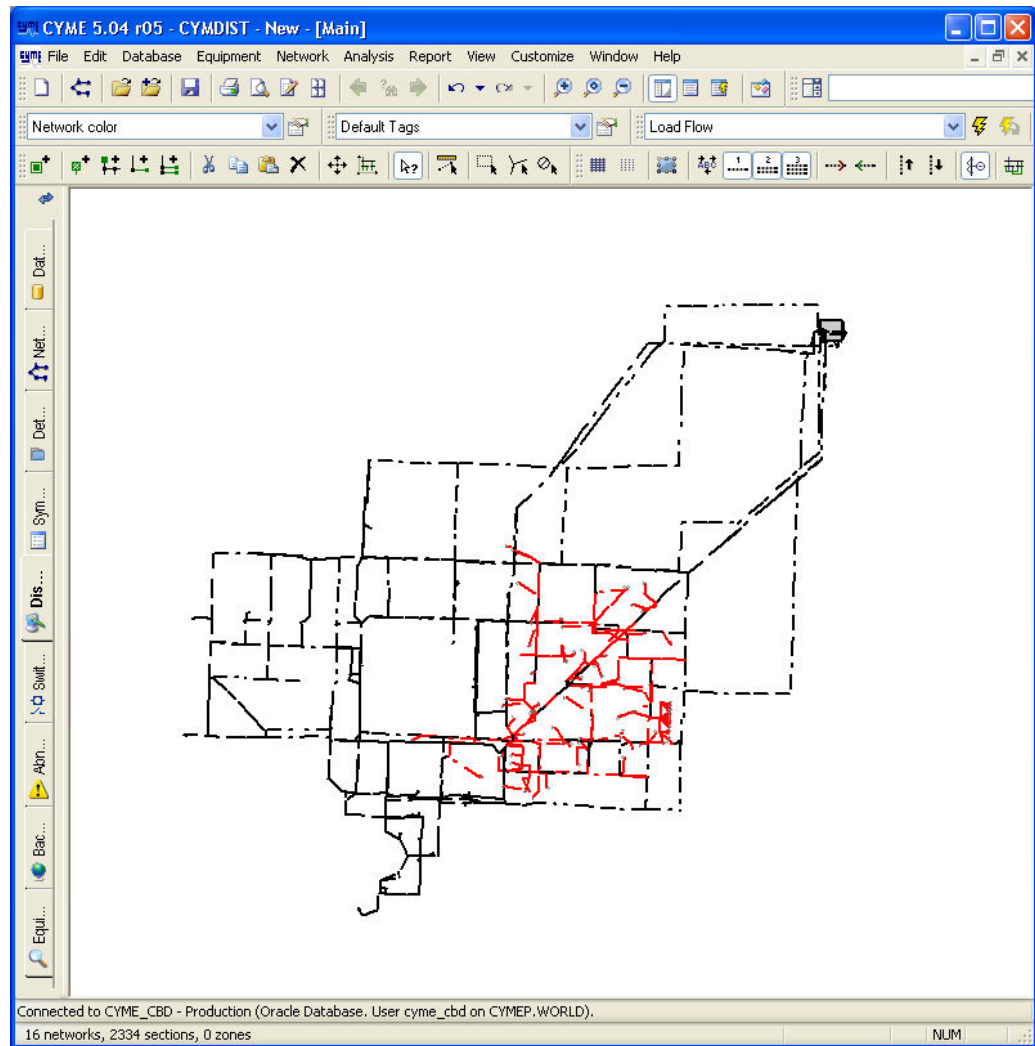


Figure 4-9 High level view of CYME model

#### **4.5. Recommendation #10: Oil Testing & FR Fluid**

*Re-evaluate Dissolved Gas Analysis (DGA) on network transformers, and explore the possibilities for fire retardant dielectric in vaults.*

##### **4.5.1. Implementation status**

As of December 31, 2012 IPL completed Recommendation #10.

IPL met all of the specific commitments associated with this recommendation.

##### **4.5.2. Accomplishments**

**Retro-fill terminations** - IPL completed the retro-filling of all 315 termination chambers on each network transformer with the FR3 insulating fluid. This is a full year ahead of schedule.

**DGA tests complete** - IPL performed DGA tests on all 315 network transformers establishing a baseline value for each network transformer.

**Fire prevented** - On July 4, 2012, a termination chamber failure occurred on a network transformer in the vault at the Westin Hotel. This unit had been retro-filled with FR3 fire retardant insulating fluid. The FR3 fluid performed well by quickly self-extinguishing after the termination chamber failed.

**Appropriate response** - The DGA test on the termination chamber on one of the network transformer units in the 24 W Washington Street vault showed a high DGA test result. IPL immediately removed the unit from service and performed an internal inspection. The internal inspection did not reveal any apparent reason for the high DGA test. Therefore, IPL returned the unit to service and scheduled a follow-up DGA test. The subsequent DGA test indicated normal conditions allowing the unit to remain in service.

**Acceptable levels set** - IPL established initial acceptable values for the network transformer DGA results to determine when action is required. IPL will continue to work with other utilities and industry groups to refine acceptable DGA limits for network transformers.

**Data in database** - IPL keeps DGA test results in the Ivara database. Ivara generates alarms that must be acknowledged when they exceed certain thresholds.



## 5. Summary and conclusion

Overall, Consulting O'Neill has now completed the scope of the consulting engagement and proved to be a valuable resource. IPL essentially completed the O'Neill Consulting recommendations and has nearly satisfied all specific the commitments. Section 6 contains a table showing all of the remaining work. Most of the remaining work is IPL's ongoing commitments for reports in 2013 and 2014.

Overall, IPL raised the standard of care for network assets, accelerated asset replacement, and improved internal asset management processes. IPL remains committed to providing safe and reliable electric service to all of its customers. The efforts IPL have undertaken to address concerns raised with its downtown network system are an indication of IPL's commitment to its customers and to the City of Indianapolis. Completion of the action items for the ten recommendations is not the end, but just a step in an ongoing process. While the action items for the ten recommendations are all nearly complete, most are just part of longer term enhancements to our processes, procedures, asset management philosophies, and overall improvements in safety, reliability and customer satisfaction.

## 6. List of ongoing reports and follow - up

IPL committed to provide status updates to the IURC during scheduled meetings at the request of the IURC and in annual "IPL Update to the O'Neill Recommendations" filings to the IURC by January 31, 2013 and 2014. Most of the specific commitments have been met. Some commitments specifically state continuation into 2013 and 2014. Subject to IURC approval, IPL plans to report on unfinished business and ongoing reports for 2013 and 2014. Those items already reported complete in 2012 would not be reported again in 2013 or 2014. Table 6-1 lists the items that IPL believes require update reports for 2013 and 2014.

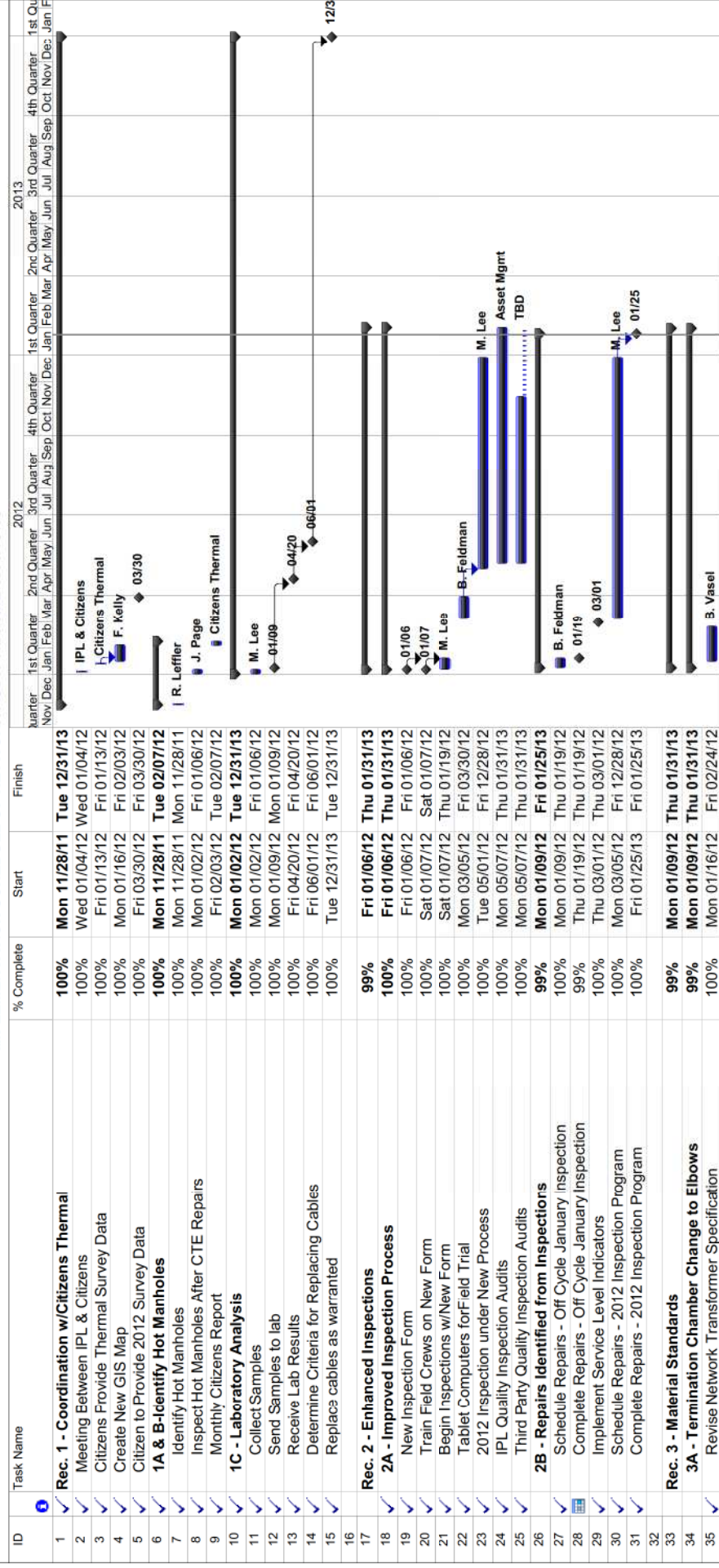
Recommendation	Continuation item	Report Action
3 - Material standards	Report effectiveness of standards change and shields	Due end of 2013
4 - Network protectors and transformers	Report 2013 and 2014 replacement volume	Submit report at the end of 2013 and 2014
5 - Asset management	Additional resources and process	Additional report due at the end of 2013
6 - Inspection technology	Report results at the end of 2013 and 2014	Submit report at the end of 2013 and 2014
7 - SCADA project	Publish final business practices	Third quarter 2013
8 - Small scale technology	Fault detectors	Install on last circuit after proactive cable replacement
8 - Small scale technology	Swiveloc™ lift/locking manhole covers in selected locations	Install complete - Report on effectiveness in 2014
9 - GIS mapping and modeling	Build model of secondary network	Complete, incorporate use into Engineering design process

Table 6-1 IPL ongoing report and follow-up commitments

## APPENDIX A - IPL SCHEDULE GANTT CHART

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Appendix pages A-1 to A-4 follow.

# IMPLEMENTATION SCHEDULE OF NETWORK AUDIT RECOMMENDATIONS



Project: Action Plan Schedule  
Date: Thu 01/24/13

Task: Spill, Milestone, Summary, Project Summary

External Tasks: External Milestone, Inactive Task, Inactive Milestone, Inactive Summary

Manual Task: Manual Task, Duration-only, Manual Summary Rollup, Manual Summary, Start-only

Finish-only, Progress, Deadline

# IMPLEMENTATION SCHEDULE OF NETWORK AUDIT RECOMMENDATIONS

ID	Task Name	% Complete	Start	Finish	2013											
					1st Quarter Nov	2nd Quarter Dec	3rd Quarter Jan	4th Quarter Feb	1st Quarter Mar	2nd Quarter Apr	3rd Quarter May	4th Quarter Jun	1st Quarter Jul	2nd Quarter Aug	3rd Quarter Sep	4th Quarter Oct
36	Revised Construction Standards Drawings	100%	Mon 01/09/12	Fri 01/27/12												
37	Modify existing stock units	10%	Fri 09/28/12	Fri 09/28/12												
38	Modified units available for installation	100%	Mon 10/01/12	Mon 10/01/12												
39	Report on Installation of Modified Units	100%	Thu 01/31/13	Thu 01/31/13												
40	<b>3B - Install Deflector Shield</b>	100%	Mon 01/09/12	Thu 01/31/13												
41	Revised Construction Standards	100%	Mon 01/09/12	Fri 01/27/12												
42	Install Additional Locations for Installation	100%	Fri 12/28/12	Fri 12/28/12												
43	Report on Installation of Progress	100%	Thu 01/31/13	Thu 01/31/13												
44																
45	<b>Rec. 4 - Network Protectors &amp; Transformers</b>	96%	Thu 01/12/12	Thu 01/31/13												
46	<b>4A - Protectors with Aluminum Bus</b>	100%	Fri 03/30/12	Fri 03/30/12												
47	Finalize Potential Locations of Protectors with AL Bus	100%	Fri 03/30/12	Fri 03/30/12												
48	Sample 100% of Possible Units with AL Bus	100%	Fri 03/30/12	Fri 03/30/12												
49	<b>4B - Protectors with Water Ingress</b>	95%	Thu 01/12/12	Thu 01/31/13												
50	Begin Inspecting & Pressure Test Protectors with AL Bus	100%	Fri 03/30/12	Fri 03/30/12												
51	Complete Toluene Gas Testing of Network Protectors	100%	Fri 09/28/12	Fri 09/28/12												
52	Develop Repair Plan from Inspection Results	100%	Fri 06/29/12	Fri 06/29/12												
53	Revised Protector Venting Practice	80%	Fri 06/29/12	Fri 06/29/12												
54	Begin Repair/Replace Protectors based on New Criteria	100%	Mon 07/02/12	Mon 07/02/12												
55	Report on Progress	100%	Thu 01/31/13	Thu 01/31/13												
56			Thu 01/12/12	Thu 01/12/12												
57	<b>4C - Transformer &amp; Protector Replacements</b>	97%	Thu 01/12/12	Thu 01/31/13												
58	Continue Current Practice & Report Progress	100%	Thu 01/31/13	Thu 01/31/13												
59			Thu 01/12/12	Thu 01/12/12												
60	<b>Rec. 5 - Asset Management Procedures</b>	100%	Mon 01/09/12	Thu 01/31/13												
61	<b>5A - Failure Analysis Process</b>	100%	Mon 01/09/12	Fri 06/29/12												
62	Load Jan.-July 2011 Data into DB	100%	Fri 03/30/12	Fri 03/30/12												
63	Update RCA Procedures	100%	Fri 06/29/12	Fri 06/29/12												
64	Notify IJRC of Reportable Events	100%	Mon 01/09/12	Mon 01/09/12												
65	<b>5B - Resource Planning for Maint. &amp; Equip.. Replacement</b>	100%	Mon 01/09/12	Thu 01/31/13												
66	<b>5A - Asset Management Staffing</b>	100%	Mon 01/09/12	Thu 01/31/13												
67	Hire New Asset Mgmt Engineer (In Progress)	100%	Thu 03/01/12	Thu 03/01/12												
68	Continue use of Consultant	100%	Mon 01/09/12	Mon 01/09/12												
69	Report Progress	100%	Thu 01/31/13	Thu 01/31/13												
70	<b>5B - Fault Analysis Process</b>	100%	Fri 03/30/12	Thu 01/31/13												

Task

Spill

Milestone

Summary

Project Summary

External Task

External Milestone

Inactive Task

Inactive Milestone

Inactive Summary

Manual Task

Duration-only

Manual Summary Rollup

Manual Summary

Start-only

Finish-only

Progress

Deadline

Project: Action Plan Schedule

Date: Thu 01/24/13

# IMPLEMENTATION SCHEDULE OF NETWORK AUDIT RECOMMENDATIONS

ID	Task Name	% Complete	Start	Finish	2013											
					1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
71	✓ Add JAN-AUG 2011 Data to the Database	100%	Fri 03/30/12	Fri 03/30/12												
72	✓ Integrate with Ivra Asset Mgmt System	100%	Fri 12/28/12	Fri 12/28/12												
73	✓ Report Progress	100%	Thu 01/31/13	Thu 01/31/13												
74	✓ 5C - Condition Based Equipment Replacement Process	100%	Fri 12/28/12	Thu 01/31/13												
75	✓ Complete Development of Criteria and Process	100%	Fri 12/28/12	Fri 12/28/12												
76	✓ Report Progress	100%	Thu 01/31/13	Thu 01/31/13												
77																
78	✓ Rec. 6 - Technology Improvements	99%	Mon 01/02/12	Thu 01/31/13												
79	✓ 6A - Tablet Computers	100%	Mon 01/02/12	Thu 01/31/13												
80	✓ Purchase Devices	100%	Mon 01/02/12	Mon 01/02/12												
81	✓ Program Device & Begin Field Trials	100%	Fri 03/30/12	Fri 03/30/12												
82	✓ Report on Progress	100%	Thu 01/31/13	Thu 01/31/13												
83	✓ 6B - Integrate Tablet Computers with Rec. 1, 2, and 5	99%	Thu 01/12/12	Thu 01/31/13												
84	✓ Make GIS data available on Tablet	0%	Fri 12/28/12	Fri 12/28/12												
85	✓ Rec. 1 Integration Plan	100%	Fri 03/30/12	Fri 03/30/12												
86	✓ Rec. 2 Integration Plan	100%	Fri 03/30/12	Fri 03/30/12												
87	✓ Rec. 5 Integration Plan	100%	Fri 03/30/12	Fri 03/30/12												
88	✓ Report on Progress	100%	Thu 01/31/13	Thu 01/31/13												
89			Thu 01/12/12	Thu 01/12/12												
90	✓ Rec. 7 - SCADA Project	85%	Thu 01/12/12	Fri 09/27/13												
91	✓ Complete Update of Deployment Plan	100%	Fri 03/30/12	Fri 03/30/12												
92	✓ Complete Identification of Users	100%	Fri 06/29/12	Fri 06/29/12												
93	✓ Complete User Training & Final Business Practices	50%	Fri 09/27/13	Fri 09/27/13												
94	✓ Report on Progress	100%	Thu 01/31/13	Thu 01/31/13												
95			Thu 01/12/12	Thu 01/12/12												
96	✓ Rec. 8 - Small scale Technology	99%	Mon 01/09/12	Fri 01/31/14												
97	✓ 8A - Thermal Imaging	100%	Mon 01/09/12	Fri 12/28/12												
98	✓ Acquire Additional Cameras	100%	Mon 01/09/12	Mon 01/09/12												
99	✓ Use for with 2012 Inspections	100%	Mon 01/09/12	Fri 12/28/12												
100	✓ 8B - Fault Direction Indicators	75%	Thu 01/12/12	Fri 12/28/12												
101	✓ Issue Purchase Order	100%	Fri 06/29/12	Fri 06/29/12												
102	✓ Install Indicators	98%	Fri 12/28/12	Fri 12/28/12												
103			Thu 01/12/12	Thu 01/12/12												
104	✓ 8C - Swiveloc Manhole Covers	100%	Thu 01/19/12	Fri 01/31/14												
105	✓ Complete Initial Installations	100%	Thu 01/19/12	Thu 01/19/12												

Task

Spill

Milestone

Summary

Project Summary

External Tasks

External Milestone

Inactive Task

Inactive Milestone

Inactive Summary

Manual Task

Duration-only

Manual Summary Rollup

Manual Summary

Start-only

Finish-only

Progress

Deadline



